that at 93 feet above. But in fact there is always a strong radiation to the ground from a layer of cloud. The sun heats the upper surface of the clouds, and by convection the influence of this heat is felt at the lower surface, which latter is also warmed or cooled, as the case may be, by radiation between it and the ground. One may often notice how rapidly the ground dries up as the fog lifts, although the sun is still invisible. It is evident that something of this kind took place in the present case since the lower thermometer was warmer than the upper thermometer by a quantity that kept on increasing up to 3 p. m. and then rapidly diminished. The wind near the ground was too feeble to nullify the radiation from the lawn. It was much stronger at the 93-foot level. The upper thermometer gave the temperature of a general layer of wind; the lower thermometer had a temperature due to radiation from the lawn, and not necessarily the temperature of the lower air.

In conclusion we may say that this unusual difference of from 4° to 6° in a vertical distance of 90 feet, even if it were demonstrated by unexceptionable apparatus to really exist is not an *inversion*, as the observer called it, of the ordinary vertical temperature gradient. The ordinary gradient is defined as being a diminution of temperature with increasing height above ground, and that is what was recorded in the present case. An *inversion* is an increase of temperature with height above ground, such as occurs during a few hours in the early morning under a clear sky, and especially when hoar frost is deposited from still air.

When the vertical gradient is a diminution at the rate of 1° C. for 99 or 100 meters, or 1° F. for 183 or 187 feet, this is called the adiabatic gradient and the air is said to be in a state of neutral equilibrium, because a mass of it raised or lowered by any number of feet will be cooled by expansion or warmed by compression to such an extent as to have the same temperature as the surrounding air in its new locality; hence the air whose location has thus been changed has no tendency to move from the place to which it has attained. On the other hand, if the rate of diminution with ascent is greater than 1° for 187 feet, as in the present case, where it was, at 3 p. m., 1° for 16 feet, then the upper air has a tendency to descend, and the lower air a tendency to ascend and to keep on ascending or descending indefinitely, so that the air is said to be in a condition of unstable convective equilibrium, such as occurs in the hotter portion of every clear day near the surface of the earth.

If the rate of descent is less than 1° for 187 feet, and especially if it becomes negative, that is to say, colder below and warmer above, then the air is in a state of stable equilibrium, and if raised or lowered tends to return to its original position.

UTILIZATION OF FOG.

On page 101 of this number of the MONTHLY WEATHER REVIEW we publish an interesting article by Mr. A. McL. Hawks, C. E., of Tacoma, Wash., on the subject of the utilization of fog for irrigation on the coast of southern California. His communication was suggested by the remarks of the Editor, published in the MONTHLY WEATHER REVIEW for October, 1898. Mr. Hawks states very truly that expensive mechanical means for collecting the fog will not be practicable. Indeed, the Editor substantially said the same thing in October, and suggested that some simple method be devised for catching the fog and forcing it to drip to the roots of the plants as useful water.

The use of liquid air, as suggested by Mr. Hawks, would undoubtedly be one of the most expensive methods of catching the fog and there is room for grave doubt whether any fog at all could be condensed by its use. Liquid air is the remarkable product of a powerful steam engine and appropriate apparatus. When manufactured, even on a large scale, it is not likely to cost less than 25 cents a gallon or to be sold for less than double that price. If one simply needs to have a cooling agent in order to condense the fog into drops, one might, far more economically, make use of artificial ice or the original brine bath and the ammonia coils of a refrigerating apparatus. The evaporation of liquid air back into the free atmosphere, which is the experiment that is now being daily shown to hundreds of people, does not produce the least sensible influence on the temperature of the audience chambers where the experiments are performed and would have still less effect over the orchards of southern California.

Mr. Hawks suggests a second method for attacking the problem, viz, the construction of a flue or smokestack leading from the cooler air above the fog down through the warm air to the earth's surface, in order that the cold air may descend through it to the ground. But the upper cold air really does not need any such conducting flue, it will descend of itself if the conditions are proper; otherwise, it can not be brought down except by the use of some extraneous expensive force and if brought down would be warmed up so much by the compression due to the greater barometric pressure near the earth's surface that it would not produce rain, but become a veritable warm, dry chinook.

But there is a third and most valuable suggestion in the letter of Mr. Hawks. He has observed that shiny black-painted iron or shiny freshly painted boards exposed horizontally are great moisture gatherers. It is evident from his statements that a concave painted board or a concave sheet or trough of painted iron will collect much moisture. If such a concave surface has a gentle inclination toward the ground, the moisture should drip in a steady stream all night long from the lower end, and can, therefore, be gathered in reservoirs or pails or led directly to the roots of the plants. This drip, as we stated in the October REVIEW, is that which maintains the verdure of Green Mountain on the Island of Ascension. It is well worth while for the agriculturists of southern California to follow out this line of experiment in the matter of utilizing the fog.

THE BLUE COLOR OF THE SKY.

The March report of the Montana section contains an interesting article by A. H. Thiessen, on the cause of the blue color of the sky. This was first explained by Rayleigh as probably due to the so-called selective reflection of the blue light in a beam of sunshine by the finest particles of aqueous vapor and dust. Mr. Thiessen gives a very simple statement of Rayleigh's explanation and we quote the following from his article:

On a cloudless day when looking away from the sun toward the sky we observe its blue color. We are then looking into space, but our line of sight is intercepted by a multitude of dust particles suspended in the air. The color of these particles is observed to be blue. This is due to their reflecting to our eyes the blue rays against which they form an effective barrier, while the red or coarser waved rays pass on.

The color of skylight is due then to the reflection of the shorter wave lengths to the eye. The air itself has no power to reflect light, but it contains innumerable dust particles which present a vast reflecting surface to the light waves. That the dust reflects back only the blue rays is due to their microscopic size. The finer the dust then the purer is the blue which is reflected or scattered. One may expect then to find the bluest skies in those places where the dust particles are smallest, and it is true that the blue of the sky as seen from the tops of mountains is deeper and purer than that seen from a lower altitude. This is due to the fact that the air is very rare at great heights and can only sustain the finer particles of dust, while the coarser particles abound at the lower levels. The sky of Italy is noted for its clearness. The blue is deeper, not because the dust there is finer than in the northern countries, but because in the countries of the north, due to the greater coolness of the air, the vapor more readily condenses upon the dust particles. The dust particles thus become larger and consequently not so effective in turning back the blue rays alone, but others are also reflected and a grayish effect is produced. In a single location the blue of the sky may appear bluer at one time than another. The sky is oftentimes said to be very blue when some white cumulus clouds are outlined against it. The sky is then a deep blue by contrast with the brilliant white. After a shower, when the lower stratum of air is washed of its coarse dust particles, a deeper and purer blue is the result.

As one looks toward the sun, especially at sunset, the reds are prominent. The dust particles are then between the sun and the observer, and so the blues are reflected away from the observer while the reds pass on to the observer's eye. One might suppose that the sun ought to appear red rather than white when one looks directly at it, because the stratum of air containing the dust is between the observer and the sun and thus there would be a diminution of the shorter wave rays to the eye. This is explained by assuming that the sun is really blue if observed from a point beyond our atmosphere; the subtraction of the blue rays as they are scattered by the particles in our atmosphere is just sufficient to produce the white sun as it appears to us.

The same mail brings us the latest contribution of Lord Rayleigh to this subject, viz, an article published by him in the April number of the L. E. D. Phil. Mag. (5) XLVII, pp. 375–384. In this article Lord Rayleigh shows that we may not need to have recourse to the suspended particles of foreign matter, solid or liquid, but that in the absence of these we should still have blue sky if the molecules of the atmospheric gases are large enough or massive enough to produce either diffraction or selective reflection. The same train of argument can be applied to the case of a beam of light passing through a shower of falling raindrops or through a mist or a cloud. As an illustration the following example is computed. Let a be the radius of a raindrop or cloud particle, expressed in centimeters as the unit of length; n the number of drops per cubic centimeter; x the length of path of the ray of light through the cloud. Then the length of path required in order to reduce the intensity of the light from 1 down to 0.37, or in the ratio 2.7 to 1 is given by:

$$x = \frac{1}{n \pi a^2}$$

Suppose that $a = \frac{1}{20}$ of a centimeter and $n = \frac{1}{1000}$ that is to say, suppose there is one drop of 1 millimeter in diameter for every liter of space, then the transmitted light will be reduced to one-third (0.37) of the original intensity when it has passed through 1 kilometer of the resulting hazy air. According to this theory a distant point of light seen through a shower of rain ultimately becomes invisible, not by failure of definition, but by loss of intensity (either the absolute intensity or that relative to the intensity of the scattered light in the neighborhood of the object) due to the diffractive action of the raindrops or fog particles.

Lord Rayleigh adds:

> If the view suggested in the present paper that a large part of the light from the sky is diffracted from the molecules themselves be correct, then the observed incomplete polarization at 90° from the sun may be partly due to the molecules behaving rather as elongated bodies with indifferent orientation than as spheres of homogeneous material.

ABSTRACTS OF UNIVERSITY THESES.

In order to attain the degree of Master of Arts or Master of Science, and especially that of Ph. D., all universities require the candidates to submit theses upon special subjects which they have investigated in their courses of study. These theses often contain facts and principles of general importance to science. In European universities it is quite common for such theses to be published, and as we have remarked in the MONTHLY WEATHER REVIEW for September, 1898, page 413, the thousands of theses that have been published within the past century constitute an important portion of the grand structure called science. In so far as the theses at American universities bear upon the work of the Weather Bureau, the Editor will be glad to receive from the authors either full abstracts or the originals for publication in the MONTHLY WEATHER REVIEW. The number of theses submitted by successful candidates for the degree of Ph. D., in the summer of 1898, in some branch of science was as follows:

Chicago	12	Wisconsin	2
Yale	11	Bryn Mawr	1
Johns Hopkins	19	Leland Stanford, Jr.	2
Harvard	11	Nebraska	2
Pennsylvania	8	Brown	1
Columbia	10	California	1
Cornell	11	Columbian	1
Clark	12	Minnesota	0
Michigan	0		
New York	1	Total	105

In addition to the universities we must also consider the schools of technology, thus, in the catalogue of the Massachusetts Institute of Technology for the year 1898–99, we find enumerated 204 theses of successful candidates, five of whom took the degree of Master of Science, while the remainder took the degree of Bachelor of Science. The thorough courses of instruction in dynamics, thermodynamics, hydraulics, and pneumatics given at this institution justify the hope that among these many candidates there must be at least a few whose attention has been turned toward the problems of meteorology.

STORM CENTERS IN THE PACIFIC.

The Pilot Chart of the North Pacific Ocean for the month of May, 1899, contains a synoptic weather chart of the eastern portion of the North Pacific Ocean for Greenwich noon of March 7, 1898. This is one of the few cases in which a fairly satisfactory synoptic chart has been published showing the isobars and winds around a storm center in the North Pacific. The abundance of reports received by the U. S. Hydrographic Office, will, we hope, encourage that important office to compile and publish such charts daily, for there could be no more important contribution to our knowledge of the meteorology of the ocean. In the present case an important storm center is shown to be central at N. 33°, W. 132°, midway between San Francisco and Honolulu, directly in the path of many sailing vessels and steamers. The daily map of the Weather Bureau shows that at this time the low area extended eastward across the Rocky Mountain Plateau region, and that storm centers were also present there. This is, therefore, a case of a very long oval, almost a trough, stretching in a northeast or east-northeast and southwest direction, between the tropical high area on the Pacific and one that at that time prevailed in the eastern portion of the American Continent.

The mere fact that such extensive troughs, containing several special centers of low pressure, can exist for several days, moving as a whole eastward, while the individual lows may move either southeast or northeast, suffices to show that the thin layer of air near the surface, within which the clouds and rain and high winds occur, is but a small portion of the whole atmospheric disturbance. The latter generally begins with a trough of low pressure and but slight cloudiness; as the clouds rapidly increase and the sun's heat is absorbed by them, the lower winds increase, the pressure falls, rain sets in, and special low areas develop within the trough.

The special low centers and cyclonic winds may be formed, according to Espy's and Ferrel's views, as a consequence of the formation of clouds and rain, and the disturbance of thermal equilibrium, but the original trough of low pressure appears to be a mechanical result of the general circulation of the atmosphere which forms the several tropical areas of high pressure and the troughs that separate them, including